Alberta

Some Studies of Alberta's Coal Geology

Projects supported in part
by the Alberta/Canada Energy
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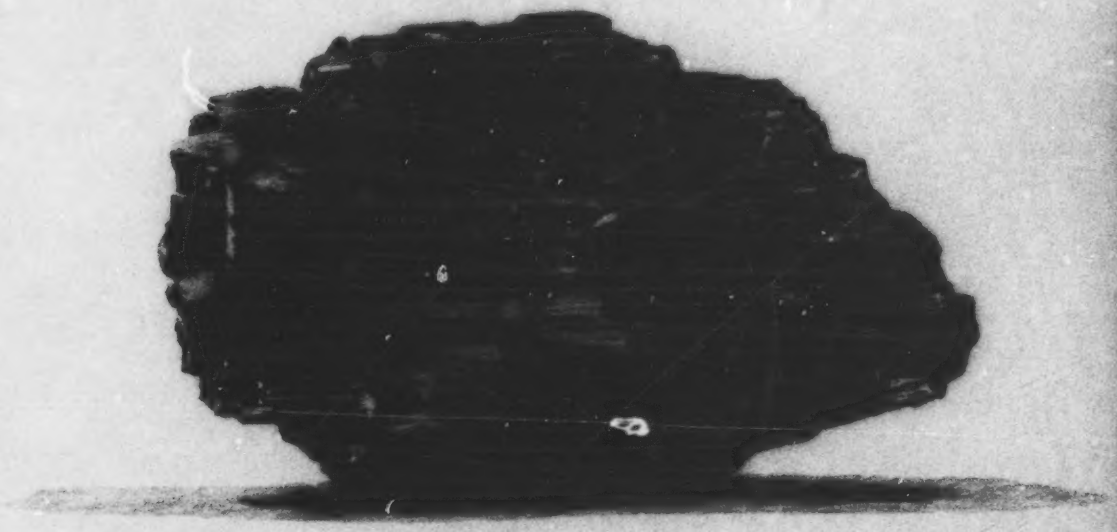
and the Alberta Department
of Energy



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COAL

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Foreword

Beginning in 1976, numerous projects were initiated in Alberta by industry and academic research institutions to help make better use of Alberta's energy resources.

These research, development and demonstration efforts were funded by the Alberta/Canada Energy Resources Research Fund (A/CERRF), which was established as a result of the 1974 agreement on oil prices between the federal government and the producing provinces.

Responsibility for applying and administering the fund rested with the A/CERRF Committee, made up of senior Alberta and federal government officials.

A/CERRF program priorities focused primarily on coal, energy conservation and renewable energy, and conventional energy resources. In 1988/89, a hydrogen research component was added.

Administration for the A/CERRF program was provided by staff within the Research and Technology Branch of Alberta Energy.

In recognition of the importance of coal to Alberta's economy, the Alberta Office of Coal Research and Technology was established in 1984 within Alberta Energy and Natural Resources (now Alberta Energy). Its primary purpose is to encourage the development and application of new technologies related to Alberta coals. The Office provides funding contributions to research and development projects in industry, academic institutions and other research establishments. It also monitors the progress of these projects in an overall program of improving the production, transportation and marketability of Alberta coals.

The A/CERRF program ended on March 31, 1991, and the support it provided has been replaced by funding from the Alberta government.

A series of technology transfer booklets, begun in 1986 with A/CERRF support, continues to make research results available to industry and others who can use the information. This service will continue until all A/CERRF projects have been described.

For more information about other publications in the series, please refer to page 12.

Some Studies of Alberta's Coal Geology

The importance of geology to Alberta's coal industry cannot be overestimated. Without a knowledge of where the coal can be found, there would be no coal industry. But knowing the approximate location of coal seams is no longer enough. These days, within the influences of international competition, environmental concerns and low commodity prices, mine operators need to know both the location and the likely quality of hidden coal resources.

Consequently, the Alberta Department of Energy has for many years been assisting the Alberta Geological Survey in carrying out studies of Alberta's mineral resources, including coal. Also, two studies of certain aspects of Alberta's coal geology were carried out at the University of Alberta and the University of Calgary under the auspices of the Alberta/Canada Energy Resources Research Fund.

The results of all these investigations are highlighted here.

Analysis of Coal-Bearing Strata Near Cadomin

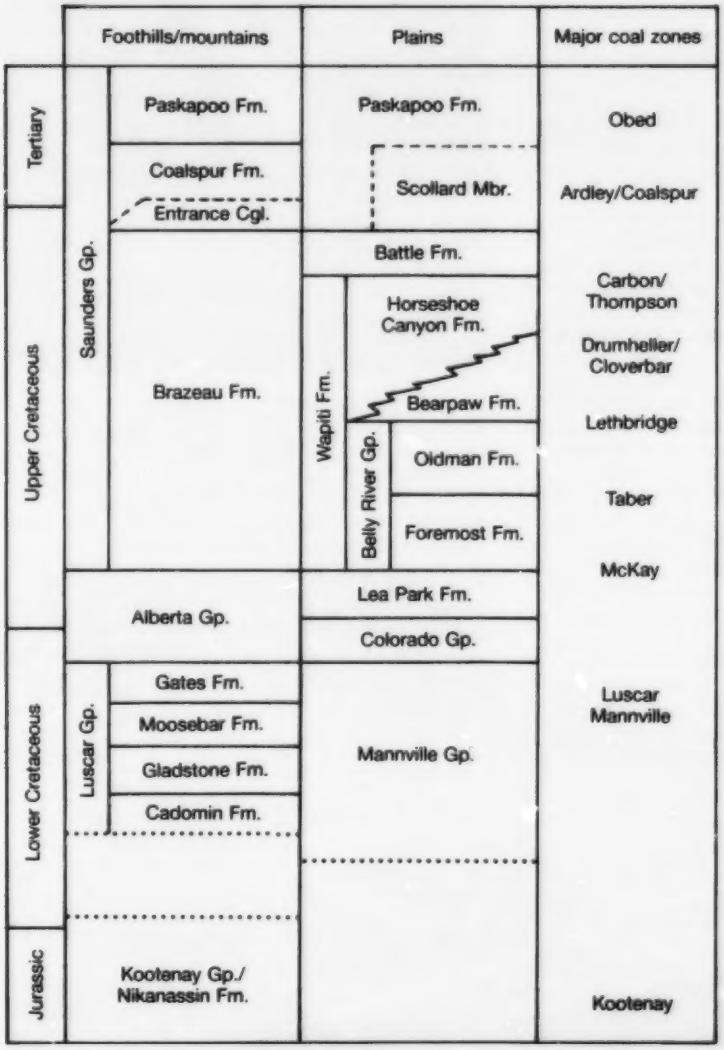
In 1981, a study was completed of the coal-bearing and adjacent strata near Cadomin, Alberta. This area of Alberta was chosen because it is the site of past and current coal-mining activity.

The study described the five units comprising the Luscar Group and provided detailed lithologic sections. The coal-bearing and adjacent strata were interpreted as occurring in three structural units, each of which came into existence at different times during mountain building (orogenesis). The structure of each unit was described. The investigation revealed that some coal seams in the Luscar Group may be more widespread than was believed previously. Also, it was proposed that three structural mechanisms were dominant during deformation of the Luscar Group. They were: low angle thrusting, flexural-slip folding and kink folding.

Included in the study was a description of an automated procedure for preparing structure contour and overburden thickness maps from outcrop data. It was suggested that this procedure should be useful during the initial stages of an exploration project when drill hole data are either too few to use conventional contouring procedures or are non-existent. Also described was an automated, computer-based system for collecting, storing, editing, retrieving and processing certain data from outcrops and drill holes. The system is also interactive and portable.

Data used by the computerized system can be retrieved on the basis of data type, outcrop or drill hole number, stratigraphic horizon, structural type and geographic location. Retrieved data can be used to plot maps showing the locations of drill hole collars, intersected horizons and outcrop structures. Also, it is possible to plot orientation diagrams and calculate parameters that describe the orientation of retrieved structures. Computer plots on which structural cross-sections can be drawn, and on which structure contour and overburden thickness maps can be constructed, are possible with this system. Detailed information about the system is available from the Department of Geology, University of Alberta.

Table of coal-bearing rock units and coal zones in Alberta



(Source: Geological Studies of Coal in Alberta: A Status Report, Langenberg, C.W., D.E. Macdonald and R.J.H. Richardson, Open File Report 1986-14, Alberta Geological Survey, Alberta Research Council, 1986.)

Three-Dimensional Structural Geometries of Imbricated Thrust Sheets

The coal contained in the Alberta foothills and mountain coalfields is the result of thickening and repetition of seams by folding and thrust faulting. The complexity of these structures, however, makes it difficult to determine or predict the three-dimensional extent of coal deposits. In the past, trenches, tunnels and drill holes were used to delineate structures, often at great expense to mining companies and the environment.

In a study carried out by the Department of Geology and Geophysics at The University of Calgary, similar structural information was obtained by using non-invasive methods such as surface mapping, new geometric techniques and computer mapping combined with existing well and seismic data.

Three areas of imbricate thrusting and folding of Jura-Cretaceous strata in the Highwood and Oldman coal basins were chosen for this study because they expose a broad range of complex structures in three thrust sheets. The thrust sheets were: Livingstone, Highwood-Elbow and McConnell. Each of the three areas was mapped at a scale of 1:10 000, and hundreds of bedding, fault, fold and slickenside measurements were collected for statistical analysis. The analyzed data were used to determine the trend and plunge of the local projection axes. The three-dimensional geometry of the area was revealed when surface, well and seismic data were projected into a series of right sections perpendicular to the regional trend, and longitudinal sections parallel to the regional trend.

These data were then used to construct balanced cross-sections and palinspastic reconstructions. Computer modelling was used to fit the data.

The resulting sections delineated well-constrained structures to depths of 5 000 m. Many structures had not been recognized previously. It was found that the three-dimensional configurations of the coal-bearing strata vary over short distances. Field data from this study have shed new light on the development, delineation and prediction of similar structures in the eastern foothills belt of southern Alberta. It is believed that use of the techniques developed in this project could lead to economic savings during the early stages of coal exploration in this and other thrust belts. This results from the ability of the technique to identify shallowly buried reserves based on an examination of the surface geometry of the overlying strata.

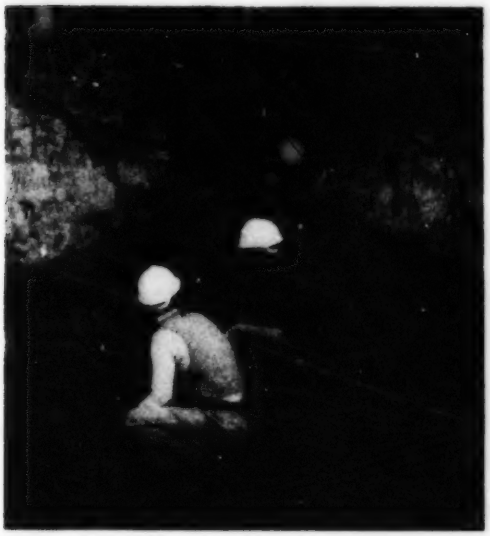
Alberta Coal Geology Program

The Alberta Coal Geology Program was funded jointly by the Alberta Office of Coal Research and Technology and the Alberta Research Council. Its overall objective was to improve the Alberta coal geology information base in areas where it was deficient so that industry and government can focus better on future coal development plans.

From 1974 to 1986, a coal exploration program carried out by the Alberta Research Council made a general assessment of coal reserves in Alberta's plains region, including the development of methods to predict the distribution, thickness and continuity of coal seams.

Analysis of the Livingstone Thrust Plate (shown here) revealed the complex structural environment in which coal is found.

(Source: The University of Calgary)



In 1986/87, a three-year program was initiated that placed greater emphasis on coal quality in the plains, foothills and mountain regions. This project was divided into several projects, which are described below.

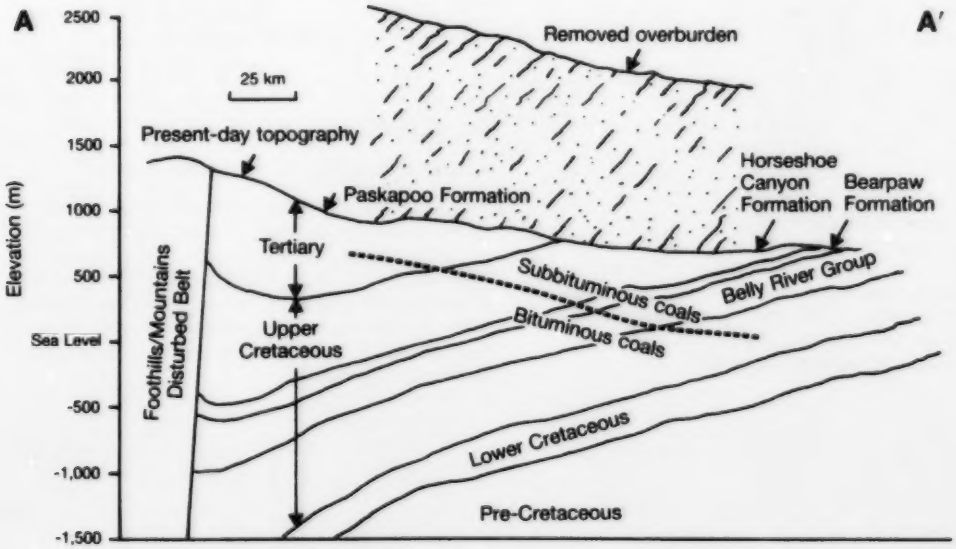
Quality of Plains Coal

In response to the need by coal companies and planners to predict confidently the properties of coal at varying distances from known data points, geostatistical and geological models for the plains region were developed. Specifically, the work focused on the factors controlling coal quality in the Ardley coal zone (Paskapoo Formation).

Some of the early detailed work included examining six coal seams at the Highvale mine site to quantify the degree of variability in coal quality factors. Also, a regional mapping investigation for near-surface coals in the Ardley coal zone was completed. Coal-quality maps were produced for ash and sulphur. The maps displayed an uneven distribution of data locations (caused by a concentration of drill holes in active mining areas) and a large range of values (perhaps caused by variations in sampling technique). This showed that sampling bias must be considered in future coal quality programs. The investigation indicated that the Highvale and Genesee mine sites have the lowest ash and sulphur coals within the Ardley coal zone.

The frequency distributions of ash and sulphur were analysed using probability density functions.

Generalized cross-section through the central plains area of Alberta, showing the southwesterly dipping coal-bearing formations and isorank lines.



(Source: Geological Studies of Coal in Alberta: A Status Report, Langenberg, C.W., D.E. Macdonald and R.J.H. Richardson, Open File Report 1986-14, Alberta Geological Survey, Alberta Research Council, 1986.)

Coal-Quality Data Acquisition

Based on the study of the Ardley coal zone, a coal-quality predictive model was developed that should be useful for interpreting and evaluating coals formed in sedimentary (depositional) environments similar to the broad terrestrial freshwater swamps that lay between large, widely spaced drainage courses in which Ardley coals were formed. In addition to these modelling studies, co-operative data acquisition programs with industry were undertaken.

Data evaluation was concentrated primarily on a relatively small, but intensively sampled, area of the Highvale mine, 70 km west of Edmonton. In addition to the mathematical models created, bar graphs, line graphs and tables were prepared to allow rapid visual comparisons. In carrying out these evaluations, comparisons were made of the variations in air-dried ash, sulphur content and heating value of coals within individual seams of each drill hole in the area.

A Regional Evaluation of Coal Quality in the Foothills and Mountains

In earlier coal-geology investigations, a broad synthesis of coal-quality data for the plains region was made. In this part of the Coal Geology Program, the objective was to develop a better geological understanding of coal quality in the foothills and mountains.

Regional statistical and geological analyses of all publicly available coal-quality data for the foothills/mountains regions in both southern and northern Alberta were completed. The data supplied by the Energy Resources Conservation Board for the northern study were found to contain several thousand coal-quality analyses for the three primary coal zones in the area, namely Luscar, Obed Marsh and Coalspur. While this provided a reliable data set for statistical analysis, most of the data points were concentrated in and around the four operating mines. Therefore, additional sampling was undertaken.

Samples collected for coal quality determination showed that the coal rank decreases towards the southwest for the base of the Gates Formation coals. Also, maturation and coalification resulted largely from sedimentary burial, although tectonic burial also played a role. The amount of tectonic burial increases from northwest to southeast. As well, the Lower Cretaceous strata in the northern and central Alberta Foothills show examples of fold-thrust interaction.

Regional Coal Mapping

Before this project began, no consistent set of coal resource inventory maps existed for Alberta. Much of the previous mapping had been done at the turn of the century by the Geological Survey of Canada, using a variety of scales and inconsistent nomenclature, with incomplete geographic coverage.

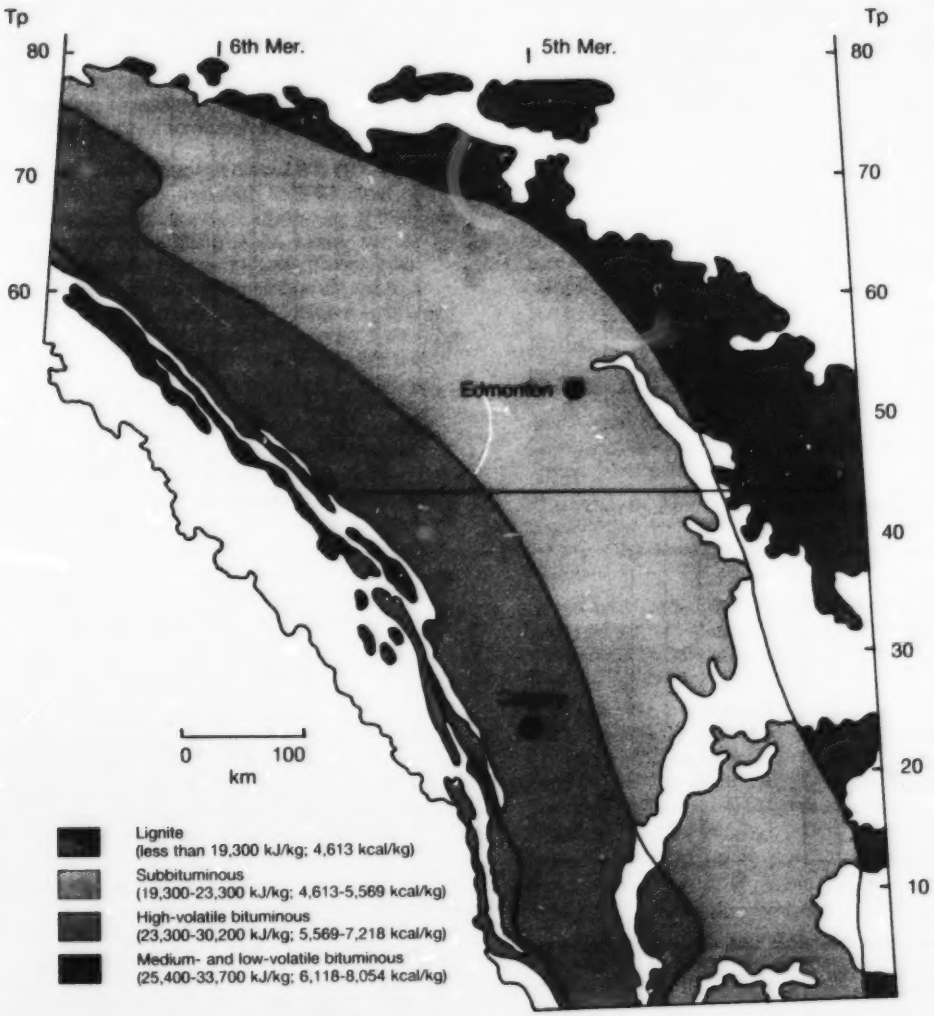
To bring this information up-to-date, coal resource maps at a scale of 1:50 000 were prepared, using a standard notation and the National Topographic System (NTS) as a base. Much has been learned this century about the structure and stratigraphy of Alberta's coal-bearing region. Thus, data were obtained from the Geological Survey of Canada, individual coal mines and the Alberta Energy Resources Conservation Board. Where information was inadequate or absent, a limited amount of field investigation was undertaken.

For each map sheet produced as a result of this activity, a coal resource map and thematic "snapshot" maps, at a scale of 1:250 000, were generated, along with accompanying text.

Foothills and Mountains Coal Quality — Local Study

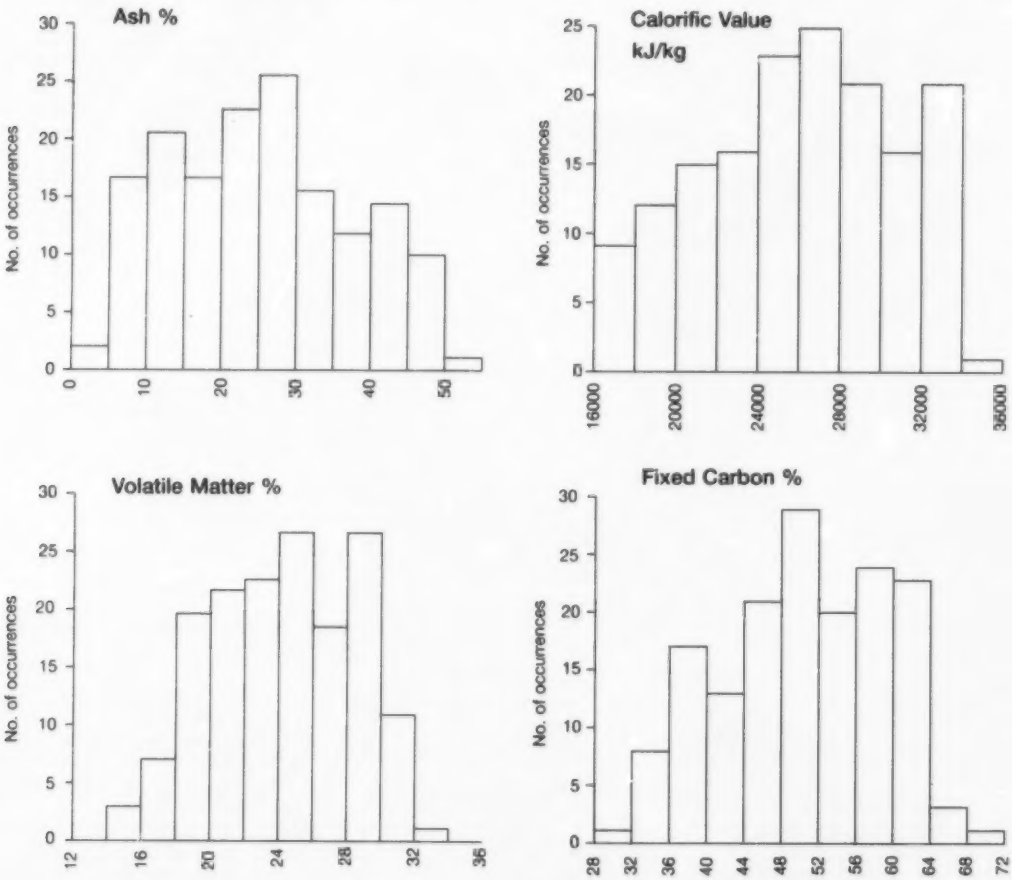
In this activity, a detailed study was made at the Cadomin-Luscar coalfield of coal-quality variations in the structurally deformed coal-bearing sequence. This was done to establish baselines for procedures to assess coal quality, to compare coal-quality data from different areas of the foothills and mountain regions, and to determine the effects of folding and faulting on coal quality.

Map showing the rank of coal-bearing strata of Alberta



(Source: Geological Studies of Coal in Alberta: A Status Report, Langenberg, C.W., D.E. Macdonald and R.J.H. Richardson, Open File Report 1986-14, Alberta Geological Survey, Alberta Research Council, 1986.)

Histograms for the variables ash, volatile matter, fixed carbon, and calorific value (dry) Luscar Group coals.



(Source: A Regional Evaluation of Coal Quality in the Southern and Central Foothills/Mountains Region of Alberta, Macdonald, D.E., N. Chidambaram, C.W. Langenberg, G.B. Mandryk, C.E. Sterenberg and A. Cameron, Alberta Geological Survey, Alberta Research Council, 1987.)

Detailed sedimentological studies were done for strata immediately overlying and underlying the major economic seam of the Cadomin-Luscar coalfield. Some variation in ash and sulphur could be explained by the sedimentary environment. Ash contents have been locally increased by tectonic shearing. Sulphur was found to vary both vertically and laterally within a single seam. Coal-rank variations were also noted within a single seam over this relatively small coalfield.

Geology of the Coalspur Coalfield

It is thought that the next thermal coal mine to be opened in Alberta may be located in the Coalspur coalfield southwest of Edson, but the area had not been mapped since 1929. Thus, mapping was undertaken to update the stratigraphic, structural and coal-quality information for this area.

As a result, the Cadomin East (NTS 83F/3 East) map sheet was completed. It shows the stratigraphic and structural framework of the coal-bearing and surrounding strata, clearly displaying the three parallel bands of coals of economic interest in the Entrance Syncline and Coalspur Triangle Zone (formerly called Coalspur Anticline). The Mercoal band is the southernmost. It contains the Mercoal Project of Manalta Coal Limited and dips approximately 30 degrees to the northeast. The southwest dipping Coalspur band is in the middle and contains the structurally thickened Coal Valley pod. It is truncated by the Pedley Thrust, which is a northeast dipping reverse fault forming the northeast side of the Coalspur Triangle Zone. The Robb band is the most northerly. It contains northeast dipping strata and is less deformed than the Coalspur band. The Bryan Mountain open pit, situated on property held by Crowsnest Resources Ltd., is located in this band.

Coal Geological Information System

In support of the other projects in the program, a data base was designed and maintained in a form useful to planners, resource managers and geoscientists. Integration of data from the Energy Resources Conservation Board, coal companies and the Alberta Research Council was completed, using the INGRES data management system. Also, development of a Geographic Information System (GIS) pilot project was initiated by mapping an area west of Edmonton that included the Genesee, Highvale and Whitewood mines. Results from this study were successfully used to demonstrate the merits of developing data-containing models for the entire province.

Coal Geology — Outreach

The primary purpose of this subproject was to foster an increased public awareness of coal geoscience through presentations by staff of Alberta Geological Survey (AGS) to community and service groups, as well as technical organizations such as The Coal Association of Canada. Also, staff exchanges with government and industry were arranged.

Under this activity, a visiting Chinese scientist was hosted, five papers and two articles were written, and AGS personnel served on several boards and committees.

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More recent information about the geology of the Cadomin-Luscar coalfield is available from:

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For additional information about the structural geometry of imbricated thrust sheets, contact:

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Other publications in this series that deal with coal research include:

An Economic Analysis of Coal Pipeline Systems, 6 pages, January 1987. (Out of print.)

Opportunities to Use Coal in Enhanced Oil Recovery, 8 pages, April 1988.

Development of an Agglomeration Process to Beneficiate and Transport Alberta Coals, 14 pages, June 1988.

Gasification of Western Canadian Coals, 14 pages, June 1988.

Coal Research Centre, Devon, 10 pages, August 1988.

Co-processing Studies of Alberta Subbituminous Coals, 14 pages, December 1988.

Mathematical Modelling of Automedium Cyclones, 10 pages, January 1989.

The Technical Committee Approach to Coal Research, 6 pages, January 1989.

Advanced Coal Mining Techniques for Alberta, 10 pages, March 1989.

Some Combustion Studies of Alberta Coals, 13 pages, May 1989

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Geotechnical Studies of Overburden and Coal at Alberta Coal Mines, 14 pages, October 1990.

Studies of Some Fundamental Properties of Coal and Potential Uses for Coal, 11 pages, August 1991.

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